General Dynamics Amphibious Systems

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Annual Report
Virginia Environmental Excellence (E-2) Program
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PURPOSE

General Dynamics Amphibious Systems has developed a first-class operation to design and build a new class of amphibious vehicles for the US Marine Corps. This report highlights some of the conspicuously innovative concepts implemented by this program to ensure high standards of compliance with environmental and pollution prevention laws.

EFV OVERVIEW

The Advanced Amphibious Assault Vehicle (EFV) is a self-deploying, high water speed, fully tracked, armored amphibious assault personnel carrier. The vehicle carries 17 combat equipped Marines and has a crew of three. The EFVs land mobility is equivalent to that of the M1A1 Main Battle Tank (MBT), achieving a speed of 48 miles per hour on land. In the high water speed mode, the EFV can plane over the water at speeds in excess of 20 knots.

The Direct Reporting Program Manager, Advanced Amphibious Assault (DRPM AAA) is responsible for the design, development, test, procurement, fielding, and life cycle support of the EFV.

The EFV is in the design and development phase, specifically System Design and Development. Low-Rate Initial Production is not expected until 2005. Full-Rate Production will occur in 2006.

As of December 2003, General Dynamics has two facilities in Woodbridge Virginia; an Advanced Amphibious Assault Vehicle Technology Center at 991 Annapolis Way, and a Worth Avenue Technology Annex at 14041 Worth Avenue. At the Annapolis Way facility the basic design of the vehicle was proven through three prototypes designed and built during 1997 – 2001. The Worth Avenue facility will mature the design through production of 8 Enhanced Manufacturing Design (EMD) prototypes and refinement of the assembly line processes needed to build 1000 vehicles.

ORIGINALITY AND PUBLIC PURPOSE

- The DRPM AAA has made environmental protection, including an Ozone Depleting Substance (ODS)-free EFV design, an integral consideration in all its acquisition processes. The DRPM AAA mandated that the design of the EFV be done *correctly* "the first time" and continue doing it right *early* in its development cycle. The DRPM AAA made a conscious decision that no Class I or II ODS will be used in the design of the EFV. This avoids damage to the environment and costly retrofitting. Even in the face of increasing schedule and performance constraints the EFV program has continued to remain ODS free in design and maintenance. Maintenance and shop floor areas are spot checked to ensure all products used for the program and for the facilities are ODS free. The environmental engineer approves all Material Requests, each critical item development specification and each engineering drawing to ensure all parts are compliant. Environmental, Safety, Health personnel and Materials engineers carefully review each potential product before it is approved for use in the program. All procurement personnel have been educated on products that may contain ODS chemicals. Procurement personnel will not approve material requests for any product containing an ODS. While this review process takes a little more time, it is more environmentally responsible and results in a cleaner environment.

- During the selection process for the design and development contract of the EFV, the DRPM AAA included specific evaluation criteria on environmental protection. Each offeror was required to submit a Pollution Prevention Plan in response to the Request For Proposal, which described how the offeror would provide environmental protection. A critical aspect of source selection for all products was a product line free of Class I and II ODS.

- The use of the Environmental Protection Agency (EPA) top 17 hazardous materials has been minimized in the EFV design, manufacturing processes, and repair procedures. This design requirement has been applied to all components in the EFV, and has been communicated to each vendor and sub contractor as a condition of their participation in the EFV program. The design contractor, General Dynamics Amphibious Systems (GDAMS), and all subcontractors and vendors must modify their components and production processes to eliminate the use of ODS and other hazardous materials to comply with the Design Specification. The EFV program's influence has been extended to other programs through dialogue, message traffic and publicity for environmental stewardship. Changes in production processes based on the EFV Design Specification has benefited other Department of Defense (DoD) Program Managers since many programs utilize the same components.

- Design trade studies for the EFV include environmental protection as a design selection criterion. This process insures the selection of the best design alternative while considering hazardous material minimization; ODS-free materials; and global warmer elimination. This has also proven to be a cost reduction measure as we select products that perform the task while minimizing disposal costs.

ACCOMPLISHMENTS DURING 2003

Reinforcement of Environmental Constraints

Perhaps the largest environmental accomplishment the company made is that each of 22 engineering design teams was held to the principles of an environmentally responsible design. The Environmental engineer maintained dialogue with and supported each of the 22 product design teams. Additionally, to maintain environmental consciousness the environmental engineer provided monthly environmental notes of interest to the entire production team including several items of interest to spouses and children at home. (Examples are at attachment 1).

Review and Reduction of Products and Materials

Environmental, Safety, Materials Engineers and Industrial health Engineers carefully research each material selected for the EFV program before the product is approved for use. In 2003 we reviewed and reduced the number of products used by 17.5 %. We continue to control materials and ensure we use products that will do the job with minimal damage to the environment, at reasonable cost, and with minimal disposal costs. This single measure has resulted in significant cost-savings and cost avoidance because materials selected do not require specialized handling, involve health risks, or require elaborate disposal considerations. More importantly we are able to produce this major weapons system in an environmentally responsible manner. RCRA compliance, clean air compliance and clean water compliance are all simplified due to our integrated, and environmentally responsible approach. (Statistics on products reviewed at attachment 2.) Another fringe benefit to Virginia is in the way work is delegated and organized for assemblies brought to Northern Virginia for integration in the EFV. Parts that must be painted are painted by the vendor producing the part, thereby reducing the total amount of VOC's emitted in Virginia and reducing the need for paint booths and environmental permitting.

Parts Washer Selection

The EFV program selected an environmentally friendly parts washer for facilities that will support the EFV program, which will eventually be nation-wide in support of Marine Corps bases around the country. Each of the bio-degradable parts washers performs its task well and at a significant savings over traditional solvent-based parts washers. Use of traditional solvent based parts washer systems requires replenishment of the solvents every one or two months depending on frequency of use. Each replenishment costs about 320 dollars, (variable based on quantity needed and frequency of use,). The total amortization cost of a Bio-degradable parts washing application is about $320.00 per **year** with no monthly fee which is very low especially when considering life cycle costs. An estimate from another parts washer vendor was $230.00 per month. The environmentally sound approach requires no monthly fee for a disposal contractor to come to the facility and remove hazardous and toxic wastes. There is no fire risk, no risk of a toxic or hazardous spill with expensive clean-up procedures, and it even saves us the cost of hand degreasing creams for our mechanics. We do not need to buy LAVA or other degreasing soaps for the Marine's hands, the Bio-degradable parts washer fluid will

clean hands too. When considering only two facilities our cost savings are around $1,500 per year. (Savings worksheet is at attachment 3.)

Banned Products: The environmental engineer banned all products containing n-hexane a chemical used in processing rubber and plastics. N-Hexane can cause permanent nerve damage on a first time use. A thorough review of all products carried by General Dynamics offices around the country revealed a few paints and solvents with N-Hexane The GDAMS environmental engineer explained the hazards of n-hexane to corporate headquarters and within 6 months all General Dynamics offices discontinued use of products containing n-hexane. On August 4th 2003, the Washington Post carried a two page article on the health damage caused by n-hexane to workers in China in the shoe industry with detailed coverage of the horrific health effects of continued exposure to n-hexane. Not only are we protecting the environment in Virginia, but we are protecting the health of our employees and protecting the corporation against potential law suits. (Article from Washington Post is at attachment 4)

Coordination with Test Sites

The EFV program conscientiously coordinates and checks with each test site, locally and elsewhere in the country to ensure environmental, health and safety concerns are addressed with all stakeholders. We may not always make every group happy, but none can say we did not carefully consider their needs and concerns. An updated compact disk with the latest version of all approved chemicals is provided to each test sites on a periodic basis to ensure all test sites know which products are authorized. So far there have been no surprises to any of the test sites concerning any aspect of this program. There have been no accidents or incidents that caused concern to a local community and no incident has occurred to alarm any community. The program looks at the chemistry of the vehicle in light of the restricted environments it will likely meet elsewhere in the country. **A database is being developed to track the total volume of chemicals that might be used at any given site in order to ensure we do not overburden a local area with a clean water or clean air compliance issue.** Additionally, the environmental engineer has presented briefings to the Department of Environmental Quality, the College of Civil and Environmental Engineering at Virginia Tech, the American Society of Naval Engineers, the annual Environment Virginia conference in Lexington, VA, Auditors in training for the Department of Environmental Quality, and other groups concerning the development of this program. The consistent message is that it is possible to develop an environmentally responsible program and that this program will remain environmentally sound.

Developed Environmentally friendly coatings:

The EFV program has worked closely with nationally recognized laboratories in three states to develop an environmentally friendly formulation of two breakthrough products: an environmentally friendly CARC (Chemical Agent Resistant Coating) and TCP (Trivalent Chromium Protection). Military vehicles must be equipped to operate in environments contaminated with Nuclear, Biological or Chemical atmospheres. Therefor the exterior surface of military vehicles is coated with a Chemical Agent Resistant Coating or CARC. Standard CARC contains significant quantities of hexavalent chromium, which is a known carcinogen. The EFV program spent many hours working

with the US Army Research Laboratory in Aberdeen Proving grounds Maryland, the Naval Surface Warfare Center, and Hentzen Coatings to develop a CARC hat has no hexavalent chrome. This new CARC contains a fraction of the Volatile Organic Compounds (VOCs) of previous formulations. The new CARC has an additional benefit that was not requested, but offers a great advantage in that it is not flammable. The EFV is the first full-scale vehicle to use the new CARC and prove the value of this environmentally friendly coating. Initial applications uncovered issues with how the coating is applied, and developed process sheets to resolve them. The cost savings in using the new CARC is still under study, but the health aspects and environmental advantages are clear. The new water based CARC is saving us thousands of dollars per year in shipping and coating costs. Former formulations of CARC contained 7.4 pounds of VOCs per gallon and the newest formulations contain 1.08 – 1.2 pounds per gallon. This represents a significant reduction in total annual emissions for the various facilities that will use the new CARC to paint military vehicles across the nation.
Additionally the EFV materials engineers worked with the Naval Air systems command to develop an environmentally responsible protective coating for our aluminum-based hull. The industry standard anti-corrosion coating for aluminum uses hexavalent chrome, the shiny finish seen on commercial airliners and most military and civil aircraft. The industry didn't want to change from 'what works' to anything else, especially if it is expensive. However there are increasing concerns that hexavalent chrome is a carcinogen and that other products might be possible that would not contain a hazardous ingredient. Over the past 5 years the AAAV and EFV programs have pushed the laboratories to come up with a better solution that is less harmful to the environment. In 2001 and 2002 a new product called Trivalent Chromium Protection was formulated, tested and validated. The EFV program will be the first to use the TCP in a full-scale vehicle. As with the CARC, the cost impacts are still under study but the immediate health and environmental advantages are substantial.

The hub assemblies for the vehicle no longer contain hexavalent chrome coatings nor cadmium: Initial Prototypes used off the shelf hub assemblies to save on engineering and development costs. However hubs that fit the AAAV design contained cadmium and chrome. The AAAV program contacted the office responsible for the design that had incorporated the cadmium and chrome into those hub assemblies and requested that they change their design to become more environmentally responsible. Over the course of two years, discussions yielded a change in design to stainless steel and anodized coatings that are more environmentally responsible. As of January 2004 all the hub assemblies for the EMD vehicles will be cadmium and chromate free.

HAZMAT Management
The EFV program has consistently required all Purchase orders to be approved by the environmental engineer as a measure of control on the purchase of products that meet the stringent environmental requirements of this program. General Dynamics Amphibious Systems also took steps in 2003 to tighten our hazardous materials management plan. We have re-written our contingency plans to include more detail about emergency equipment and emergency contacts. Additionally, we have invited the local Police and fire fighting personnel to each facility to familiarize them with locations of any product that might

produce a toxic environment in a fire. This information is now posted at several locations within the facility. We have also trained a broader group of employees in hazardous waste management allowing greater effectiveness and efficiency.

Wastewater and Waste Stream Issues

We have virtually eliminated pollution from waste stream operations and we have reduced the risk of spill and contamination associated with these processes. The floors of our facilities are sealed so that no waste that falls on the floor can spill out to the environment. A series of spill containment kits are available around the shop floor to contain fluids in the event of an emergency. However the implementation of a "pharmacy concept" where technicians can only obtain the minimum necessary quantities, ensures that containers on the shop floor are sized to meet the need with little excess. This means that any spill will be very small; the largest quantity that can be spilled is about one gallon of fluid. We also have ongoing audits to reduce spill risks. We are currently looking at one wastestream that is disposed of off-site as mixed oily waste water to determine if we might be able to evaporate it on-site.

FUTURE GOALS

Environmental Management System

We continuously review our Environmental Policy and practices to see what improvements can be made to reduce cost and improve efficiency. We have a number of auditors from outside sources and a variety of visitors whose observations are folded into ongoing reviews. As an example, during the year 2002, the Virginia Department of Environmental quality asked if we would host a group of environmental auditors in training. During their visit, the environmental engineer asked each of them for at least one idea on how to improve the plant or processes they had toured. In all four of those student observations were integrated into our daily operations. We will continue to aggressively seek ways to better the operation of both General Dynamics Facilities in Woodbridge, VA.

Growth: In 2003 General Dynamics announced the selection of Possum Point as the site for the production of the next 1000 vehicles. During late 2003 and 2004 we will work closely with developers and State regulators to ensure incorporation of desirable features in the design of an environmentally sound production facility. This 58 million dollar facility will be sited to be a best solution for all stake holders. We have already instituted a series of meetings with the state and local environmental officials to ensure this goal.

Hazardous Waste

At this point our Woodbridge operations generate a very small quantity of waste, only a small percent of which is oily mixed wastewater. We intend to scrutinize all our waste processes with an eye toward reduction.

Review of all Materials and Chemistry

Currently, the EFV production process involves the use of 2,279 chemical substances. The first review of our chemistry reduced 61 products involving approximately 130 chemicals. During 2004 we plan to conduct another top to bottom review of all the chemicals in an attempt to further simplify the chemistry of the EFV. We also carefully review any product with Volatile Organic Compounds and try to distribute the VOC's by having the vendors apply coatings at their facilities before the product is shipped to us thereby reducing VOC's emitted in the Northern Virginia region.

Energy Consumption

In our Worth Avenue Facility we have learned there is an opportunity to reduce the heating requirements during the heating season and possibly a way to reduce the lighting requirements for the assembly line. We are investigating the possibility of reducing the costs of lighting and heating.

Planning:
General Dynamics Amphibious Systems is planning a new facility in the Possum Point / Quantico Creek area of Northern Virginia. GDAMS is working diligently with all stakeholders and the environmental community to ensure this facility will be state of the art, environmentally sound, and a showcase for how a production facility should be built. We are currently discussing the proposed facility with State and local Department of Environmental Quality leaders to ensure we build the facility with state preferences on items such as mechanical air extraction systems, stormwater retention areas and water discharge from the building. Where we can accommodate State preferences, we are incorporating those requests in the facility design.

SUMMARY: The EFV program has taken bold steps to influence industry in the use of paints, coatings and materials in order to show that a major weapon system can be manufactured in an environmentally responsible manner. The steps taken are consciously designed to help ensure a cleaner future and to prove that even a weapon system can be designed and built with minimal impact to the environment.

Inclosure 2
Statistics on products in use.

Total number of products in the EFV database : 757
Some of these products may have as many as 20 ingredient chemicals

Total number of Chemicals involved in assembly of EFV: 1,143.

Total number of discontinued products in the EFV database: 46

Total products used in assembly and production of the EFV: 620

Total number of products with at least one hazardous ingredient : 183 *

Total number of products reviewed and rejected for environmental, health, or Safety concerns: 675

* This includes chemicals that can be considered hazardous based on mis-application or carelessness such as Super Glue which can be hazardous if it gets in your yes or contacts soft tissue.